A CALANOID COPEPOD FOR INTENSIVE CULTIVATION

Reliable provision of suitable food for larvae has been an obstacle to successful cultivation of many marine fish species (Kahan *et al.*, 1981/82; Bromage *et al.*, 1988). Small fish larvae require food which, as well as being nutritionally adequate and of appropriate size, elicits a feeding response by its active movement. Artificial foods do not, at present, meet all of these criteria (Wanatabe 1988). Nauplii of *Artemia* and some species of rotifers are used as live food items but copepods, especially copepod nauplii, may be more suitable for very small fish larvae. Copepods are probably important natural food items for many fish, they are naturally rich in essential fatty acids (Stottrup *et al.*, 1986) and are abundant in many parts of the sea. Although cultivation of marine copepods has been successfully achieved (Klein Breteler and Gonzalez, 1986) the animals are not widely available at low cost. Our work with *Gladioferens imparipes* suggests that this species is ideal for intensive low cost cultivation. Animals can be made available as live food, as ecotoxicological test organisms or for research. This contribution describes those aspects of the biology of *G. imparipes* which makes the animal suitable as live food in aquaculture.

Gladioferens imparipes is physiologically robust. Populations occur in estuaries of southwestern Australia which are characterized by marked seasonal changes in salinity and conspicuous vertical salinity discontinuities. Vigorous populations can occur both at low salinity (2 ppt) and in hypersaline conditions (38 ppt.) and in the full range of temperatures (12–28°C) which occur in these estuaries. In culturing these animals, there is no need to maintain physical conditions within close limits. We have deliberately changed the salinity of our cultures from 35 ppt to 5 ppt to rid the cultures of harpacticoid copepods and we regularly separate *G. imparipes* from other estuarine fauna by exploiting this tolerance of rapid salinity change.

G. imparipes feeds by filtering phytoplankton from water. In their natural estuarine habitat dense populations of the copepod follow high phytoplankton productivity when the seasonal run off ceases. In the laboratory, our copepod cultures have thrived on various small phytoplankton species which are easily maintained. We have successfully used strains of *Isochrysis* sp., *Pavlova* sp., *Phaeodactylum tricornutum* and several unidentified estuarine species as food. Dense copepod cultures rapidly clear algal cells from the water and cultures thrive if algae are added twice daily at densities such that water is cleared in a few hours and few old algal cells remain to contribute to reduction of water quality. *G. imparipes* is capable of rapid population growth. This is typical of ecological pioneer species which exploit newly available resources. At 22°C, females are able to reproduce *c.* 14 days after hatching. They then produce egg masses of 25–45 eggs at intervals of 2–4 days. Reproductive activity is affected by temperature and food availability, both of which can be easily manipulated in the laboratory.

G. imparipes have been maintained in our laboratory through 28 generations in 18 months. Comparisons between animals bred for 18 generations in the laboratory and first generation laboratory animals showed no diminution of reproductive activity but a slight reduction in age at maturity for the 18th generation animals.

G. imparipes eggs are carried by females until nauplii hatch. An egg carrying female presents both a conspicuous visual target and a valuable food item to a predator. For animals in cultivation, we have developed a quick method for determining whether a population is reproducing to capacity. An index of fecundity is obtained by examining about 15 living females and giving each a score based on presence or absence of an egg mass, size of the egg mass and whether or not the uterus is full of eggs. The index of fecundity has been shown to relate closely to the level of food provided and therefore permits us to adjust rations by biological criteria.

G. imparipes nauplii exhibit moderately strong phototactic behaviour. We have designed a trap to regularly remove nauplii from our culture containers. Nauplii are attracted to a point source of light and then removed from the culture by siphon. An arrangement of air lift pumps and time switches permits regular automatic operation of the nauplius trap. We have recorded daily production in excess of 20,000 nauplii from a 15 litre culture.

G. imparipes nauplii have a mean body length of 128.5μm on hatching. They grow through nauplius and copepodite stages to *c.* 800μm metasome length when mature. We have shown that nauplii can be taken as food by Dolphin fish (*Coryphaena hippurus*) and we have grown Sea Horses (*Hippocampus angustus*) from hatching to 40mm using nauplii, then copepodites and adults as food. It is likely that other fish species would grow successfully on the same diet.

G. imparipes is ideally suited for relatively low cost intensive cultivation and may, therefore, be useful in marine fish aquaculture.

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